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THE SPIROCHETE OF INFECTIOUS JAUNDICE (SPIRO-
CHETA ICTEROHEMORRHAGIAE, INADA; LEP-
TOSPIRA, NOGUCHI) IN HOUSE RATS
IN CHICAGO

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In 1914 Inada and Ido¹ announced the discovery of a spirochete in the liver of a guinea-pig which had developed h morrhagic jaundice and died as the result of the inoculation of blood from a case of infectious jaundice. This spirochete Inada later found to be the etiologic factor of Weil's disease and he named it *Spirocheta icterohemorrhagiae*. Due to certain characteristics, unlike all other spirochetes, Noguchi thinks it is a new genus and suggests the name *Leptospira*.

Miyajima,² in 1915, reported that he had found spirochetes resembling those described by Inada in the kidneys of field mice, and later that he had found, also in field mice, similar spirochetes, which when injected into guinea-pigs produced fever and hemorrhage, and after a number of generations, icterus. As immune serum against the spirochete of Inada was capable of destroying these organisms he concluded that the organisms in question were identical.

In 1917 Ido² and his co-workers observed two typical cases of spirochetosis icterohemorrhagica following the bite of rats, and were thus led to believe that the rat plays an important part in the transmission of the infection. On the basis of Miyajima's reports and of their own observations they undertook a series of experiments on house and roof rats in the city of Fukuoka and its vicinity in order to determine the prevalence of the spirochete in the rat. The kidneys of 92 rats were examined and spirochetes demonstrated in 26. In the urine from 71 rats spirochetes were present in 22. The blood and liver from 64 rats showed no spirochetes. Rats were also allowed to bite guinea-pigs in their legs, and of 50 experiments thus made, one

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¹ J. Exper. Med., 1916, 23, p. 377.

² J. Exper. Med., 1917, 26, p. 341.

guinea-pig died of icterus and hemorrhages on the 11th day after the bite. No spirochetes could, however, be demonstrated in the mouth of the rat. Altogether they found the organism in question in 40% of 149 rats examined. They also examined field mice and in one instance succeeded in infecting a guinea-pig by an intraperitoneal injection of kidney emulsion.

These results appear to have been confirmed by English and other European workers, who have recovered spirochetes both from the blood and urine of soldiers with hemorrhagic jaundice in France, and have also been able to demonstrate the organisms in the kidneys of field rats, and hemorrhagic jaundice in guinea-pigs. Stokes, Ryle and Tytler³ report that 5 rats of 9 taken from a certain section of a field proved infective to guinea-pigs. From another section of the field 1 rat of 6 communicated the disease. Dawson, Hume, and Bedson⁴ report similar findings.

In the United States several workers report results similar to the Japanese and European. Noguchi⁵ found that rats captured in New York City and vicinity harbored the spirochete in question. Because he used an emulsion made from kidneys of several wild rats the exact percentage of rats communicating hemorrhagic jaundice to guinea-pigs is not known. Jobling, James, and Eggstein⁶ found that of a hundred rats captured in different parts of Nashville, Tenn., at least 10% carried the spirochetes and communicated the disease to guinea-pigs. Neill⁷ obtained a similar result from his experiments on wild rats in Washington, D.C.

In order to further extend the observations in regard to the prevalence of the causative organism of acute infectious jaundice in rats in the United States, experiments have been made on house rats captured in the basement of a hospital and of a medical college located in the City of Chicago. Thirty rats were used, a number of them being rather young. They were taken alive, killed, and one kidney aseptically removed at once. This kidney was then emulsified in salt solution, and the emulsion injected into the peritoneal cavity of a guinea-pig, one guinea-pig being used for each rat. The guinea-pig was then observed for at least 3 weeks, in most instances for 1 month.

³ *Lancet*, 1917, 192, p. 142.

⁴ *Brit. Med. Jour.*, 1917, 2, p. 345.

⁵ *J. Exper. Med.*, 1917, 25, p. 755.

⁶ *Jour. Am. Med. Assn.*, 1917, 69, p. 1787.

⁷ *Pub. Health Rep.*, May 10, 1918, p. 717.

The results of these observations were all negative. None of the guinea-pigs died, and at no time did they show any symptoms of hemorrhagic jaundice.

The other kidney together with the suprarenals, liver and spleen, the heart, lungs and the testicles were treated according to Levaditi's silver method and examined for spirochetes. A large number of individual sections from each organ were examined carefully, especial attention being given to the kidney, because it is in this organ that the spirochete has been found in the rat.

Of the tissues, the kidney from one rat (No. 15) was the only organ in which spirochetes were found. Here they were seen within epithelial cells of a convoluted tubule. In no other kidney were they found. And no spirochetes were found in other organs, namely, the heart, lungs, liver, spleen, suprarenals and testicles.

Films were also made from the heart blood, urine, kidney emulsion, and from swabs of the mouth and throat and scrapings from the teeth of the rats. The material from the mouth was examined because of the report that guinea-pigs, and in several instances human beings, who had been bitten by rats contracted hemorrhagic jaundice. It would therefore be of interest to know whether or not spirochetes are present in the mouth of the rat. This proved to be the case in one instance in my series. In rat 24 spirochetes were found in material taken from the mouth. In the films made from the urine, blood and kidney emulsion no spirochetes could be demonstrated.

The spirochete observed in the kidney of rat 15 was a very slender organism. In length it varied from about the diameter of a red cell to twice that length and longer. It had many rather closely coiled undulations which at times seemed to become smaller and more crowded toward the ends. These undulations were at times rather irregular and the ends were often hooked. Some of the spirochetes were placed in such a position toward each other as to resemble a branching organism. The spirochetes found in the material from the mouth of rat 24 were similar in shape to that just described except that, due to the staining method used, it was a little thicker. The morphology of the spirochetes observed by me answers to the description of the spirochete causing infectious jaundice.

In staining films for spirochetes previous experiments had proven that Tribondeau's modification of Fontana's method was rapid and gave a very satisfactory result, hence this method was used.

CONCLUSIONS

Spirochetes resembling those described as the cause of acute infectious jaundice were demonstrated in only two Chicago house rats of 30 examined (or 6.6%), indicating that the spirochetes probably are not present in a high percentage of such rats.

The spirochetes were demonstrated in material from the mouth and in tissue from the kidney.

Because of the presence of spirochetes in the mouth of rats it is possible that, at the time of the bite, organisms may be carried into the wound by the saliva or teeth, and disease in this manner transferred directly from the rat to man.